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Findings from within-subjects comparisons of drug use and sexual risk behaviour in men who have sex with men in England

RUNNING HEAD: Within-subjects comparisons of sexualised drug use

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Conflicts of interest and source of funding

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Background. Epidemiological evidence for the encounter-level association between sexualised drug use and unprotected anal intercourse (UAI) in men who have sex with men (MSM) is unclear and has not examined MSM in England. To estimate this association, we compared dyadic sexual encounters within respondents.

Methods. We used encounter-level data from a longitudinal online survey of MSM living in England and multilevel models to test univariate and multivariate associations between any respondent or partner drug use, specific respondent drug use, additional situational characteristics and UAI.

Results. Based on 6,742 encounters from 2,142 MSM, respondent drug use, and respondent use of certain specific drugs, were associated with increased UAI odds. In univariate models, partner drug use was associated with increased UAI odds, but in multivariate models, only non-specific knowledge of partner drug use was associated with the same. Encounters with non-regular-and-steady partners or that were not HIV seroconcordant were associated with decreased UAI risk.

Discussion. This is the first within-subjects comparison of drug use and UAI conducted on a sample from England, and the largest of its kind. Findings are consistent with other studies, though associations between drug use and UAI are shaped by social contexts that may change over time.

Keywords: epidemiology, high-risk behaviour, homosexual, sexual behaviour

Introduction

Epidemiologists and health promoters have sought to understand how situational characteristics specific to sexual encounters, including drug use, are associated with sexual risk behaviours. Of the possible study designs for understanding these associations, designs that undertake ‘within-subjects’ comparisons of multiple sexual encounters are most informative, as they avoid confounding by person-level characteristics such as propensity towards risk-taking and sexual act preferences.^{1,2}

Whether drug use and sexual risk behaviour are associated at the level of the sexual encounter remains unclear. A systematic review of event-level analyses, including both single-event analyses and within-subjects comparisons, noted that evidence for associations between drug use and sexual risk behaviour is only well established for crystal methamphetamine and binge alcohol use.³ The evidence base from studies undertaking within-subjects comparisons to assess encounter-level associations between drug use and sexual risk behaviour among MSM^{4–15} is incomplete in several respects. Studies may be out of date, as the most recent study in this field collected data before 2010.⁴ These studies have often drawn on small samples, as all but one⁵ enrolled fewer than 1,000 respondents. These studies have also often considered drug use as a ‘composite’ variable covering a wide variety of different drugs,^{10–15} failing to acknowledge that specific drugs may be differentially associated with sexual risk behaviour. Finally, these studies have also been limited to those conducted in the United States or Australia, and not other countries, such as the United Kingdom.¹⁶ Existing analyses of this association in the UK context are incomplete. While the ASTRA study¹⁷ was a landmark in developing UK-specific knowledge of the association between drug use and sexual risk behaviour, it relied on a clinic-based

sample to estimate cross-sectional, global associations between drug use histories and sexual risk behaviour histories. Additional analyses on the dataset used in the current paper have focused on multipartner encounters¹⁸ and on respondent drug use in dyadic (i.e., between two partners) new partner encounters¹⁹. Neither of these analyses was conducted using within-subjects comparisons, and previous work on dyadic encounters was unable to consider partner drug use and drew on a discrete survey module. Patterns of sexual behaviour and drug use among MSM are likely to be shaped by social and cultural context, so evidence from one setting may not be readily generalizable to others.

Using data from the Sigma Panel, a longitudinal survey conducted in 2011-2012 of MSM living in England, we report within-subjects comparisons testing associations between drug use and unprotected anal intercourse. To our knowledge, this is the largest study of its kind both in terms of numbers of respondents and encounters analysed, and the first conducted in the United Kingdom.

Methods

Participants were MSM living in England aged 16 years and above. In five monthly waves of online data collection (sent 1st March 2011, 1st June 2011, 1st August 2011, 1st November 2011 and 1st February 2012), participants were asked about their most recent sexual encounter with another man.

To avoid confounding or effect modification by the number of partners per encounter, we restricted this analysis to dyadic encounters. We compared encounters in which unprotected anal intercourse (UAI) was reported against all other sexual encounters as the dependent variable in all models. In this analysis, we included all

MSM who completed at least one of these monthly waves with information about a dyadic encounter.

Detailed survey methods are published elsewhere.²⁰ In short, MSM were recruited via online dating websites, completion of a previous survey and email bulletins, and participants completed all surveys online. The survey was approved by the London School of Hygiene and Tropical Medicine ethics committee (approval number 5834). This analysis was approved by the Department of Social Policy and Intervention research ethics committee at the University of Oxford.

Drug use measures. Participants were asked about both their use of poppers before sex and their use of alcohol or other drugs before sex separately using binary items. If participants reported using alcohol or other drugs before sex, they were prompted to select from a list of 13 specific drugs (alcohol / Viagra®, Cialis®, Levitra® or other drugs that help to keep an erection / cannabis / ecstasy (E, XTC, MDMA) / amphetamine (speed) / crystal methamphetamine (crystal, meth, Tina) / heroin / mephedrone (4-MMC, meow, methylone, bubbles) / GHB, GBL (liquid ecstasy) / ketamine / LSD / cocaine / crack cocaine) plus a free-text option for ‘any other drug’.

Participants were also asked about their partners’ use of alcohol or other drugs. They were able to choose one of four responses: ‘Yes, and I know which drugs he used’, which was labelled ‘knowledge of specific drug use’, ‘Yes, but I don’t know which drugs he used’, which was labelled ‘non-specific knowledge of drug use’, ‘I don’t know if he used drugs’, which was labelled ‘unclear drug use’, and ‘No, he did not use drugs’. If they chose the first option, they were prompted to select from the same list of 13 specific drugs or to specify ‘any other drug’.

Covariates. Covariates included several situational characteristics shown to be significantly associated with UAI in within-subjects comparisons in MSM: location of sex,^{5,11,13,21} partner relationship,^{12,15} and knowledge of partner HIV seroconcordance.^{12,22} First, we classified encounters by location of sex into: private (home or hotel), sex-on-premises venue (gay sex party, backroom, sex club, porn cinema, bathhouse or sauna) or cruising location (park, public toilet or other outdoors location). Second, we classified partner relationship into: regular and steady (characterised by frequent contact, including boyfriend or husband), regular and non-steady (repeat casual sex partner known to respondent, but not a primary sex partner) or one-off (one-night stand, paid sex or partner met for anonymous sex via the internet). Third, we classified encounters into those where the participant believed he and his partner to be: HIV seroconcordant (both partners either HIV positive or HIV negative); HIV serodiscordant (one partner HIV positive, the other HIV negative) or unknown HIV match (either the participant did not know his partner's HIV status, or the participant did not believe his partner knew the participant's HIV status, or both). Finally, we included the month of reporting in multivariate models to check reactivity arising from multiple measurements.

Analytic strategy. We used random intercept models with encounters nested within participants and a Bernoulli distribution on the dependent variable. Models were estimated using maximum likelihood in Stata 13. We first estimated a null model with just the dependent variable, UAI, to estimate intra-cluster correlation. We then entered any participant drug use, participant specific drug use, any partner drug use, partner specific drug use, and each covariate into separate 'initial' models. We entered variables for specific drug use as a block both because use of specific drugs was not

exclusive of use of other specific drugs, and to isolate better any associations between specific drugs and UAI in light of the frequency of poly-drug combinations. Due to model stability, we only included specific drugs reported in more than 1% of encounters (thus excluding amphetamine (speed), heroin, mephedrone, LSD and crack cocaine).

We then constructed two multivariate models: one with any participant drug use, any partner drug use, and the full set of covariates; and one with participant specific drug use and the full set of covariates. We did not include partner specific drug use in the second multivariate model because of model instability due to the less prevalent reporting of partners' use of specific drugs. Missing data were handled by pairwise deletion because missingness was lower than 5% in all models.

Results

We included 6,742 encounters from 2,142 MSM. Each wave of data collection contributed roughly equally to the final set of encounters: 22.7% (1,528) of included encounters were reported in the first wave of data collection, 20.3% (1,369) in the second, 19.2% (1,293) in the third, 18.6% (1,253) in the fourth, and 19.3% (1,299) in the fifth. Almost half of the sample reported possessing a university degree, 82% were White British, and respondents were on average 42.5 years of age ($SD=11.9$) (see table 1). On average, participants contributed 3.1 encounters ($SD=1.5$) to the analytic sample, of which 30.9% involved UAI. A null model revealed an intra-cluster correlation of 66.8% with statistically significant variance at both the participant and encounter levels.

Initial models. Compared with encounters featuring no substance use, encounters in which the participant reported substance use on his part had significantly greater odds of UAI (OR 2.02, 95% CI [1.67, 2.45]; see table 2).

Encounters in which the participant had either specific or non-specific knowledge of his partner's drug use were associated with similarly increased odds of UAI compared to encounters with no partner's drug use. However, only those encounters in which the participant had knowledge of specific drug use rose to statistical significance (OR 1.61, 95% CI [1.29, 1.99]). Encounters in which the participant reported unclear partner drug use were associated with significantly decreased odds of UAI compared to encounters with no partner drug use (0.68, [0.49, 0.97]).

Reported use of specific drugs by the participant or partner was associated with increased odds of UAI, with the exception of alcohol use by participant and ketamine use by the partner, but neither finding was statistically significant. For both participants and partners in separate models, reported use of each of erectile dysfunction medications, crystal methamphetamine and GHB was significantly associated with increased odds of UAI. Participant use of poppers was additionally associated with increased odds of UAI (this question was not asked about partners). Partner use of cannabis was significantly associated with increased odds of UAI when controlling for other specific partner drug use, though not for participant use of cannabis.

Compared within participants to encounters in private locations, encounters in sex-on-premises venues and cruising locations were both associated with decreased odds of UAI. Encounters with partners that were not regular and steady were similarly associated with decreased odds of UAI. Finally, encounters with partners that were HIV serodiscordant or of unknown HIV status match were associated with decreased odds of UAI.

Multivariate models. Associations between any participant drug use and UAI and between participant specific drug use and UAI in multivariate models including covariates were similar to those in our initial models (see table 3). However, the pattern of results for partner overall drug use changed when this variable was included in a model with additional covariates. Specifically, associations between knowledge of specific partner drug use and increased UAI and between unclear partner drug use and decreased UAI in initial models did not remain significant in multivariate models. Non-specific knowledge of partner drug use was, however, significantly associated with increased odds of UAI (OR 1.63, 95% CI [1.01, 2.61]). Examination of the correlation matrix for included variables showed that unclear partner drug use was correlated with unknown serostatus match ($r=0.23$), non-private location of sex (sex-on-premises venues $r=0.32$ and cruising locations $r=0.15$) and one-off partners ($r=0.26$). Knowledge of specific partner drug use was also highly correlated with participant drug use ($r=0.54$).

Associations between encounters in sex-on-premises venues and less UAI were no longer significant in multivariate models, and the magnitude of the association between encounters in cruising or outdoors locations and UAI was decreased from initial models. The magnitude of associations between relationship status with partner and UAI and between perceived partner HIV seroconcordance and UAI were somewhat attenuated in multivariate models, with the exception of encounters with serodiscordant partners, which were similar in associations with lower odds of UAI across all models.

Discussion

This study presents the first evidence from England of within-subjects associations between drug use and UAI in MSM. Participant drug use, both generally

and for some specific drugs, was associated with higher odds of UAI. This association did not appear to be confounded by other key situational characteristics that have previously been shown to be significantly associated with UAI. The shift in associations between univariate and multivariate models for partner drug use may reflect how perceptions of partner drug use, rather than the fact of partner drug use, may be confounded by other key situational characteristics. This is especially likely given that unclear partner drug use was associated with encounters in locations that may be characterised by little communication between sexual partners.^{23,24} The finding that non-specific knowledge of partner drug use is associated with greater UAI mirrors findings in other studies on associations between UAI and composite drug use variables on the part of participant^{10,13} and partner.

Specific drug use. Findings from this study agree with prior evidence from a systematic review³ and specific studies^{4,5,7} about associations between crystal methamphetamine and UAI. Moreover, significant associations between use of both crystal methamphetamine and GHB and increased odds of UAI are especially important given their prominent use in ‘chemsex’ (the strategic combining of sex with drug use to enhance sexual performance and sensation) in MSM living in the United Kingdom²⁵ and other Western countries.²⁶ Furthermore, our findings that use of poppers and erectile dysfunction medications are each associated with increased odds of UAI add important epidemiological evidence to analyses that have either been at the partnership level²⁷ rather than at the level of the sexual encounter, or that have been qualitative in nature.²⁸ Poppers and erectile dysfunction medications are reported to be used in the context of UAI to facilitate receptive and insertive anal intercourse, respectively, for longer encounters and with more successive partners in one sexual session than would

otherwise be feasible.²⁵ Our finding that alcohol was not significantly associated with odds of UAI is in agreement with other within-subjects comparisons that have not found an effect,^{4,11} though other explanations include that associations between alcohol use and sexual risk are moderated by age,^{9,10} dependent on modality of UAI (i.e. receptive versus insertive UAI⁶), or dependent on the amount of alcohol consumed.⁵ We were unable to test these hypotheses in this study.

Covariates. Though the covariates included in our models were not our primary focus in this paper, findings from these analyses merit comment. Partner HIV serodiscordance and lack of familiarity are associated with decreased odds of UAI. Findings regarding location of sex and sexual risk behaviour add evidence to a specific area of investigation that, as a recent systematic review of within-subjects comparisons noted,²⁹ requires additional research. Though univariate models indicated that encounters in sex-on-premises venues and cruising locations are associated with decreased odds of UAI relative to encounters in private locations, findings on sex-on-premises venues were not significant in multivariate models. This is likely due to confounding by partner type and partner HIV seroconcordance.

Strengths and limitations. Perhaps the most important strength of this study was the combination of sample size and attention to specific drugs used. Our study's large sample size in both participants and encounters provided improved power to examine specific drug use that was rare in the sample. However, this study did not collect data using a diary format, so the maximum number of encounters per participant was five. .

A strength and limitation of these analyses was restriction of the sample to dyadic encounters. While this was useful in reducing confounding by the number of

partners per encounter, it does limit the generalisability of findings. Multipartner sexual encounters may be markedly different from dyadic encounters in terms of communication about drug use and HIV serostatus.³⁰

Our community-recruited sample consisted of more White British men and highly educated men than MSM in the UK at large. Thus, findings may not be generalisable to the entire population of MSM living in England. Community-recruited samples of MSM report higher risk than probability-based samples³¹ and recruitment source may influence results.³² To a degree, our within-subjects comparison attended to differences in baseline risk by participants, but this is not a perfect solution. As with all retrospective recall surveys, our data may be subject to recall and reactivity bias. However, asking participants about their most recent encounter at multiple time points, rather than for multiple encounters at the same time, may have attenuated this. We also controlled for wave of data collection.

Finally, a strength of our study is that, to our knowledge, our investigation contains the most recently collected data for testing within-subjects comparisons between drug use and sexual risk behaviour. However, like the studies that came before it, findings may be specific to time and place as social, legal and supply contexts for drug use change.

Directions for future research. Additional work should seek to better understand person-level moderation of encounter-level associations between drug use and sexual risk behaviour.^{9,10,15} New drug use trends will emerge as contexts change and as new compounds are synthesised. For example, though patterns of sexualised drug use by MSM in the United States have long included crystal methamphetamine, this has only been recognised in the United Kingdom in the last several years.²⁵

Moreover, when these data were collected, mephedrone use in MSM (which we were unable to analyse due to low frequency) was just emerging as a drug to be used in sexualised contexts. Though we were underpowered in these analyses to investigate differences between receptive intercourse and insertive intercourse, future analyses should also seek to illuminate differences by coital positionality in associations between drug use and sexual risk. Within-subjects comparisons of poly-drug combinations may also better approximate practices in sexualised drug use in MSM. Finally, it is important to consider moderation of encounter-level relationships by person-level characteristics, such as ethnicity, that are associated with HIV prevalence or sexual risk.

Future research into interventions for sexual risk behaviour and sexualised drug use should seek to balance person-level behaviours with situational characteristics. Our null model revealed that two-thirds of the variation in UAI across encounters was at the person-level, rather than due to differences between encounters. However, our findings also revealed specific strong associations between drug use and sexual risk behaviour. Addressing situational use of GHB and crystal methamphetamine, as well as of poppers and erectile dysfunction medications, could present a useful focus. This is especially given that many interventions for sexual risk reduction in drug-using MSM have focused on drug dependence rather than situational risk.³³

Conclusion. This study presents the first within-subjects comparison of drug use and sexual risk behaviour in MSM from a UK sample. It offers current evidence of significant associations between UAI and both any drug use and specific drugs used, including drugs implicated in chemsex, and contributes to a field in which the question of associations between drug use and sexual risk behaviour continues to be discussed.

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Table 1. Characteristics of included participants.

Variable	% (n) Mean (SD, range)
Age (n=2,134)	42.5 (11.9, 17-78)
16-19	1.3% (28)
20-29	14.7% (313)
30-39	24.2% (517)
40-49	31.3% (668)
50-59	19.5% (416)
60-69	8.2% (174)
70+	0.8% (18)
Education (n=2,129)	
Low (no secondary qual, CSE, O-level)	17.8% (379)
Medium (A-level, higher ed below degree)	32.6% (694)
High (university degree)	49.6% (1,056)
Gross income per annum (n=2,132)	
<£5,000	5.2% (111)
£5,000-£9,999	8.1% (173)
£10,000-£14,999	8.7% (185)
£15,000-£19,999	11.5% (245)
£20,000-£24,999	11.5% (246)
£25,000-£29,999	9.9% (211)
£30,000-£34,999	9.9% (211)
£35,000-£39,999	6.1% (129)
≥£40,000	22.6% (481)
Do not wish to respond	6.6% (140)
Ethnic group (n=2,126)	
White British	81.5% (1,732)
White other	13.0% (277)
Black	1.7% (37)
Asian	2.5% (54)
Other	1.2% (26)
Relationship status at enrolment (n=2,127)	
Single	52.0% (1,105)
One man only	40.0% (851)
Two or more men, no women	3.2% (68)
One or more women	4.8% (103)
Sexual identity (n=2,123)	
Gay or homosexual	85.5% (1,815)
Straight, bisexual or other	14.5% (308)

Table 2. Situational characteristics and associations with unprotected anal intercourse.

Variable	Frequencies	Unprotected anal intercourse
	% (n)	OR (95% CI)
Any drug use by participant		
No drug use	57.1% (3,833)	Reference
Yes, drug use	42.9% (2,881)	2.02*** (1.67, 2.45)
Drug use by participant: specific		
Poppers	20.5% (1,370)	2.35*** (1.84, 3.00)
Alcohol	26.5% (1,776)	0.84 (0.67, 1.05)
Erectile dysfunction medications	7.2% (485)	3.14*** (2.12, 4.67)
Cannabis	3.9% (262)	1.59 (0.95, 2.65)
MDMA	1.7% (113)	1.48 (0.67, 3.26)
Crystal methamphetamine	1.1% (72)	3.14* (1.18, 8.36)
GHB	1.4% (94)	2.32* (1.02, 5.29)
Ketamine	1.8% (119)	1.72 (0.80, 3.06)
Cocaine	2.1% (141)	1.56 (0.80, 3.06)
Any drug use by partner		
No drug use	64.0% (4,279)	Reference
Unclear drug use	7.9% (526)	0.68* (0.48, 0.97)
Non-specific knowledge of drug use	3.8% (253)	1.53 (0.99, 2.36)
Knowledge of specific drug use	24.4% (1,632)	1.61*** (1.29, 1.99)
Drug use by partner: specific		
Alcohol	20.9% (1,400)	1.09 (0.87, 1.38)
Erectile dysfunction medications	2.5% (165)	4.27*** (2.19, 8.34)
Cannabis	3.1% (205)	1.87* (1.10, 3.18)
MDMA	1.2% (83)	2.09 (0.88, 4.95)
Crystal methamphetamine	0.9% (62)	2.92* (1.00, 8.46)
GHB	1.2% (79)	3.07* (1.24, 7.64)
Ketamine	1.4% (92)	0.98 (0.43, 2.22)
Cocaine	1.8% (118)	1.84 (0.91, 3.70)
Location of sex		
Private (residence, hotel)	87.2% (5,862)	Reference
Sex-on-premises venue	7.3% (490)	0.48*** (0.33, 0.70)
Cruising or outdoors location	5.5% (371)	0.29*** (0.19, 0.46)
Relationship status with partner(s)		
Regular and steady	32.3% (2,174)	Reference
Regular, non-steady	26.3% (1,766)	0.41*** (0.32, 0.53)
One-off encounter	41.4% (2,784)	0.16*** (0.12, 0.21)
HIV serodiscordance		
Seroconcordant	43.0% (2,882)	Reference
Unknown HIV serostatus match	50.0% (3,352)	0.17*** (0.14, 0.22)
Serodiscordant	7.0% (467)	0.31*** (0.21, 0.46)

*p<0.05, **p<0.01, ***p<0.001

Table 3. Multivariate models testing associations with unprotected anal intercourse.
*p<0.05, **p<0.01, ***p<0.001

Variable	OR (95% CI)	OR (95% CI)
	n=6,582 in 2,129 groups	n=6,580 in 2,126 groups
Any drug use by participant		
No drug use	Reference	
Yes, drug use	2.15*** (1.69, 2.74)	
Drug use by participant: specific		
Poppers		2.56*** (1.99, 3.30)
Alcohol		0.85 (0.67, 1.07)
Erectile dysfunction medications		3.20*** (2.12, 4.82)
Cannabis		1.51 (0.89, 2.57)
MDMA		1.35 (0.59, 3.04)
Crystal methamphetamine		2.76* (1.00, 7.58)
GHB		2.43* (1.05, 5.66)
Ketamine		1.56 (0.71, 3.43)
Cocaine		1.67 (0.83, 3.35)
Any drug use by partner		
No drug use	Reference	
Unclear drug use	1.35 (0.91, 2.01)	
Non-specific knowledge of drug use	1.63* (1.01, 2.61)	
Knowledge of specific drug use	0.99 (0.76, 1.30)	
Location of sex		
Private (residence, hotel)	Reference	Reference
Sex-on-premises venue	1.00 (0.66, 1.52)	1.08 (0.72, 1.62)
Cruising or outdoors location	0.55* (0.34, 0.90)	0.61* (0.38, 0.98)
Relationship status with partner(s)		
Regular and steady	Reference	Reference
Regular, non-steady	0.54*** (0.41, 0.71)	0.49*** (0.37, 0.65)
One-off encounter	0.25*** (0.19, 0.34)	0.25*** (0.19, 0.33)
HIV serodiscordance		
Seroconcordant	Reference	Reference
Unknown HIV serostatus match	0.27*** (0.21, 0.35)	0.29*** (0.23, 0.37)
Serodiscordant	0.30*** (0.20, 0.45)	0.28*** (0.18, 0.42)